Super-K Detector Simulation and Reconstruction Benchmarks

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`skdetsim`

- GEANT3
- Input is vectors from neutrino or proton decay Monte Carlo (eg. `neut`)
- Output is array of digitized PMT hits in same format as SK calibrated data
- Can optionally keep array of Cherenkov photon information

Simulation Outline

Event loop:

- Track Particles (e, mu, pi, ...)
- Generate Cherenkov Light
- Reduce number of photons by QE factor
- Track Cherenkov light (scattering, absorption)

- Photon arrives at surface:
- Transmission (acrylic) or absorption or reflection
- as a function of incident angle, wavelength, and polarization

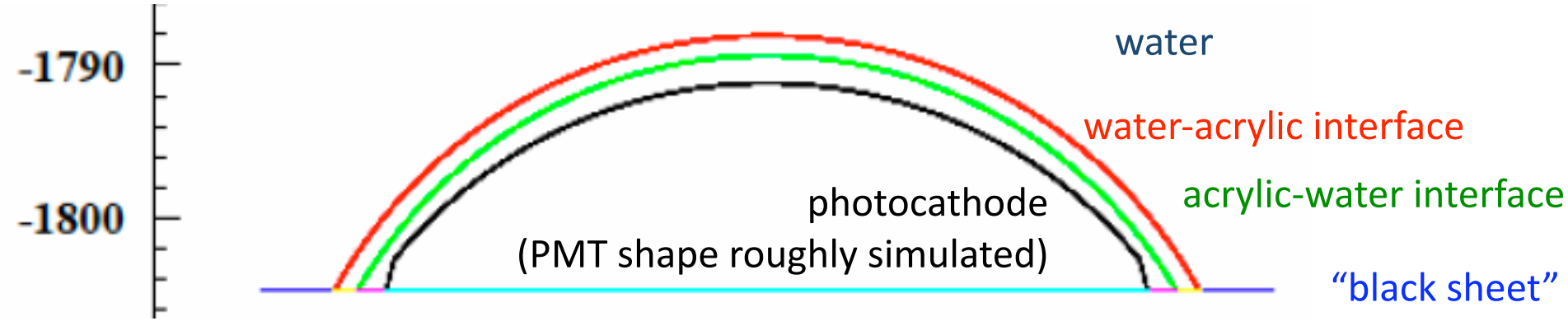
- Photon arrives at PMT:
  - correct QE
  - generate photoelectron

Reconstruction Outline

Event loop:

- vertex fit (time-based point fit)
- ring counting (up to 5!)
- particle ID (e-like/mu-like)
- refined fit based on mu/e particle ID
- muon decay electron finding
- final momentum assignment for each ring
- fake ring removal
- POLFIT – specialized pi0 fitter

PMT Regions


-1790
-1800
water
water-acrylic interface
acrylic-water interface
photocathode
(PMT shape roughly simulated)
“black sheet”

Benchmarks

For one year of atmospheric neutrino data
4900 events
output file size 1.1GB

Processing step	CPU time Xeon 2 core 3.0 GHz
Vector generation	small
Detector simulation	27 hours
Data reduction	7 hours
Event reconstruction	105 hours

Comments

For water Cherenkov detectors, the detailed Monte Carlo is an integral part of the experiment.

Monte Carlo samples of 100 to 500x running time are routinely used.

Event reconstruction time dominates.

With some reasonable assumptions, Moore's Law, storage costs etc. these simulation benchmarks can be scaled to get a first-pass estimate of the computing needs and costs for Monte Carlo simulation.